16. A power management system according to claim 2 in which at least one power controller is provided integrally with a power module wherein that power controller can receive signals from other power modules and the power module can send out signals to other power controllers indicating whether its associated component wishes to make use of any other components.

17. A power management system according to claim 3 in which switching to a low power state by a power controller takes place after a predetermined delay and a re-examination of the status of the signals from the power modules.

18. A power management system according to claim 3 in which monitoring of input signals by the power controller takes place after switching to a low power state, and the component is switched to a high power state if one of the input signals from the power modules indicates that another component wishes to make use of it.

19. A power management system according to claim 3 including a system timer to schedule predetermined switches between low and high power states.

20. A power management system according to claim 3 in which at least one power controller is provided integrally with a power module wherein that power controller can receive signals from other power modules and the power module can send out signals to other power controllers indicating whether its associated component wishes to make use of any other components.

Remarks

Applicant has amended the specification as indicated to correct spelling differentiations between spellings acceptable in the United Kingdom and what is acceptable in the United States of America. Applicant has also noted multiple dependent claims and claims dependent on multiple

dependent claims in the original priority document which are either expensive or prohibited under United States patent rules. Consequently, applicant has amended the claims to delete the multiple dependencies and add new dependent claims to fill out a twenty claim claim set.

Applicants believe no fee is due in connection with this submission. Should the Commissioner find that a fee is due, authorization is hereby given to charge any such fee, except the issue fee, to Deposit Account 19-0733.

If there are any questions the Examiner is invited to contact the undersigned at (202) 508-9119.

Respectfully submitted,

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Dated: July 23, 2001

MARKED-UP VERSION

IN THE SPECIFICATION

[1] United Kingdom Patent Application No. 9720856.5 describes a system in which devices which would benefit from being connected in a network or would normally be connected in a network are each provided with a small radio transmitter and controller which enables them to determine other objects in their vicinity which perform functions which would be of benefit to them. For example, a hand-held data ~~organiser~~organizer could download a set of telephone numbers to the internal storage of a telephone if both fitted with devices of this type.

[9] Power conservation in existing microprocessor systems is normally ~~centralised~~centralized and based on simple procedures such as time-outs and local usage monitoring. For example, in a personal computer disk drives may be switched into a low power state if no keyboard or mouse activity is detected within a predetermined time interval. This interval is normally chosen to reflect human usage patterns. It requires little change to the rest of the system but has a very coarse grained responsiveness. This is not appropriate when the emphasis is on achieving low power operation such as in embedded systems where a very fine granularity of control is desired and the emphasis is on very low power operation. In networks of this type, a much more aggressive low power strategy is therefore required such that the default state of the node can be powered off rather than on.

[10] Preferred embodiments of the present invention provide an architecture and procedures for achieving low power operation based on a flexible distributed democratic voting mechanism wherein power modules associated with specific hardware and software components express their dependencies on other node components through a simple voting procedure. As a result, only those components currently in use or needed by another component would normally be in the on state and therefore dissipating power. The system is highly modular and flexible and can accommodate a wide range of node component dependencies in an ~~organised~~organized and integrated fashion.

[18] Figure 1 (a) shows a set of nodes or communication points which are able to move around but remain in range of each other. This is referred to as a cloud of devices of the type which might be carried about by a person in luggage, in a vehicle or between a small group of people working in the same environment. Such devices can be made aware of each other via their nodes which can communicate by radio with other nodes and offer services to each other. They may be able to use each other's services sometimes for extended periods. For example, a personal data ~~organiser~~organizer may be ~~authorised~~authorized to use the mobile telephone of its user for e.g. sending and receiving messages by fax or E-mail.

[19] Figure 1 (b) shows endpoints which include nodes and which move around occasionally coming within range of other nodes that provide services to which they have no special ~~authorisation~~authorization. This is referred to as a nomadic node. The sort of services it might use are those that tell it about its environment e.g. position and local facilities, and those which might allow it to ~~personalise~~personalize another node by configuring it in a way that is suitable for a particular user. For example, a telephone may be pre-primed with a set of commonly ~~dialled~~dialed numbers when it detects a node owned by the person who has those commonly ~~dialled~~dialed numbers nearby.

[21] Systems embodying the present invention may be ~~decentralised~~decentralized. If they are, then every device must be able to independently describe itself to a sufficient level for it to be useful to others. This decentralized approach is used because knowledge about nearby objects which have nodes associated with them is more important than the knowledge of other devices which are not nearby. In particular, using such a system eliminates the need to contact and maintain a ~~centralised~~centralized database wherever a new node is encountered. That would require global connectivity.

[27] The problem is that the controller does not know when it should power the component on or off. Therefore, to influence the ~~behaviour~~ behaviorof a particular power controller, power modules are used. Each code module which wishes to influence the power controller requires a power module connected to that controller. These provide a means for voting either for or against the connected power controller entering a low power state. The power controller will enter the low power state when all associated power modules are in ~~favour~~ favor and will leave that state the moment one related power module votes against it. The mechanism whereby the signals are exchanged by power modules of the controllers is implementation and component specific. For example, in a real time message based system, these votes can be indicated by sending the appropriate message from the given power module to the power controller.

[33] Each power module may have two helper functions called Power Down FN and Power Up FN. Once active, as soon as it is established that all power module votes are in ~~favour~~ favor of powering down, the power controller will take the following steps. Every related power module which has one will have its power down FN called. After calling each power down FN, the voting is double checked. If those are still in ~~favour~~ favor, then the next power down FN is called, etc. If the low power state has been vetoed with a No vote, then the power up FN's are called for each module which previously had its power down FN called. If after notification, voting is still in ~~favour~~ favor of powering down then the power controller's power down FN is called. This initiates the powering down of the CPU hardware.

[35] During system ~~initialisation~~initialization, all power controllers will have been ~~initialised~~initialized. During this, the system will establish how many power modules wish to vote on each particular power controller. If there are no modules wishing to vote on a particular power controller, then it will be put into a low power state by calling its power down FN. Later, during normal device and process ~~initialisation~~initialization, any code which includes the power module can ~~initialise~~initialize that power controller. It is at this stage that a connection to the relevant power

controller is formed and an initial vote registered. Power controllers cannot take any power saving action until all related power modules have been ~~initialised~~initialized, otherwise the system may not start correctly.

[36] Nodes may be deployed in a variety of roles, so to simplify development, code is written in a modular fashion whereby code in each module may be written independently of and without reference to the other modules. When a node is ~~customised~~customized, for a particular role, the required code modules are linked together to form an image which is downloaded to the node. As a result, when writing a module, any decisions or actions that may conflict with other modules should be avoided. Typically, the other modules may be specified as required and their presence assumed. However, this reduces the variety of available module permutations. This has particular implications to power saving.

[40] A power controller may be provided integrally with a power module. This will lead to savings in the number of components used if hardware implemented on savings by integrating software in a software implementation. This integrated power module is then used to send signals (i.e. votes) to other power controllers indicating that its associated component wishes to make use of another component associated with another power controller.

[41] In addition to the power controller and power module functions discussed above, each node will normally have a system timer function whose operation is slightly different. The system timer is used by modules to schedule the ~~signalling~~signaling of future events. For example, in a message based implementation, this is accomplished by a code module sending the appropriate message to the system timer specifying the future event time. When this occurs, the system timer returns an appropriate message to the calling code module. Each node has a single system timer and it maintains an ordered list of all future events that have been scheduled. In particular, it keeps track of time for the next event scheduled to occur (which we will refer to as TNS).

IN THE CLAIMS

3. A power management system according to claim 1 ~~or 2~~ in which switching to a low power state by a power controller takes place after a predetermined delay and a re-examination of the status of the signals from the power modules.

4. A power management system according to claim 1~~, 2 or 3~~ in which monitoring of input signals by the power controller takes place after switching to a low power state, and the component is switched to a high power state if one of the input signals from the power modules indicates that another component wishes to make use of it.

5. A power management system according to claim 1~~any one of the preceding claims~~ including a system timer to schedule predetermined switches between low and high power states.

7. A power management system according to claims 5 ~~or 6~~ in which the system timer only causes the component to switch to a low power state if the time interval until the next scheduled high power state exceeds a predetermined limit.

8. A power management system according to claim 1~~any preceding claim~~ in which at least one power controller is provided integrally with a power module wherein that power controller can receive signals from other power modules and the power module can send out signals to other power controllers indicating whether its associated component wishes to make use of any other components.

12. A power controller according to claim 9 ~~or 10~~ wherein the apparatus is a part of a network.